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Eradicate Poison Ivy

Carcinogenesis and Tumor Growth

Apprenticeship Program in Biology

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Cover Photograph

The photographs show the sequence of cellular and nuclear divisions in living intestinal bacteria, *Escherichia coli.* The sequence of 15 photographs represents a period of 78 minutes; the cells make about 2½ divisions during this time. All pictures were taken through a phase contrast microscope by Donald J. Mason, Division of Bacteriology, Purdue University. Magnification is about 3000 X.

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Eradicate Rhus radicans!

ROBERT A. BULLINGTON
Northern Illinois State College
DeKalb, Illinois

Watch out for poison ivy! What biology teacher has not issued that warning as he conducted a field trip? In spite of this warning and constant efforts to identify the plant, many teachers and students acquire cases of poisoning during spring field trips.

Identification and avoidance are not enough. Too many people are affected inadvertently. The casual hiker, the child searching for a ball in the bushes, the lady holding her pet cat in her arms, the man standing in the smoke of burning brush, and even the gay blade who defies the plant and says he is immune—all are likely to break out with those itching painful blisters. Too, there is the inevitable student who plucks a plant and says, "Teacher, what is this?"

Poison ivy can be controlled if a real effort is made. The biology teacher is the logical one to lead the campaign for eradication of the pest from field trip areas, for poison ivy is likely to be found wherever he takes his class, whether it is to a forest preserve, the school forest, a city park, a roadside, a vacant lot, or the landscaped school grounds.

This discussion is concerned with the common poison ivy (*Rhus radicans*) which is found throughout the United States except on the West Coast, where it is replaced by the western poison oak (*R. diversiloba*). There are other poisonous species of *Rhus*, common in the eastern states, such as poison sumac (*R. vernix*) and poison oak (*R. toxicodendron*).

Rhus radicans is a perplexingly variable species, in which there are numerous varieties and forms. No attempt is made here to deal with the taxonomy of the plant. For identification purposes, the reader should consult any standard manual.[1]

Common poison ivy is very confusing in its growth habits. It may climb to the top of a tall tree, clinging by aerial roots and sending out wide branches that confuse the identity of the tree. It may creep along the ground, sending up short, upright, leaf-bearing stalks, or it may grow as a typical shrub.

Its habitats are widespread. One may find it on sand dune or beach, in swampland or upland forest, on rocky cliffs or garden wall. It grows best in shade and is usually quite dwarfed in full sunlight.

Poison ivy is shallow rooted. It spreads widely by horizontal stems growing at the soil surface under forest litter.

The poisonous principal of species of *Rhus* is urushiol, an irritating slightly volatile oil that is present throughout the plant. It is prevalent on the surface of fresh leaves, making them hazardous to touch.

So many articles concerning ivy poisoning appear each year in newspapers and magazines that no attempt will be made here to describe the symptoms or mention treatments. Our concern is to discuss methods of complete eradication of the plant from limited areas.

Eradication Procedures

Cutting the vines. Of first consideration is the elimination of the principal seed source. The mature poison ivy vines that climb the trees, often to a height of fifty feet, produce numerous seeds. A typical upland oak-hickory forest, heavily infested, may have fifty or more large vines per acre. These may have trunks up to three inches in diameter or occasionally larger. Many of these mature vines will be from twenty to thirty years of age. The author has cut one that showed fifty annual rings.

Incidentally, the rings of poison ivy vines are very easily counted, and there is a sharp distinction between the deep yellow heartwood and white sapwood.

For a radius of forty or fifty feet in all directions from the parent vine, the ground

[1]An excellent reference on poisonous species of *Rhus* is *Poison Ivy, Poison Oak, and Poison Sumac: Identification, Precautions, Eradication*, Farmers' Bulletin, No. 1972, U. S. Department of Agriculture, 1946.

A former student, James D. Barton, beginning to spray a patch of poison ivy along a path at the Lorado Taft Field Campus, Oregon, Illinois.

is usually covered with a dense growth of shrubby ivy plants, from one to four feet in height. They apparently have developed from seeds of the vine, although many may have grown vegetatively.

Killing the large vines is quite simple. One should tour the infested area armed with a sharp axe and a container of concentrated brush killer. Cut the vine at a convenient height; the wood is quite soft and cuts easily. Cover the cut surface of the stump with the brush killer. It may be squirted from an ordinary oil can or sprayed from a small bottle with a spray attachment—such as is often used with a window-cleaning solution.

Of 500 vines treated by this method, none has been observed to sprout again.

Avoid handling the axe blade, and scrub it thoroughly with hot soap solution when the job is finished.

Spraying. The spraying of the poison ivy shrubs of the forest floor cannot be done by large power equipment, if other flora are to be spared. The compressed air sprayer, funnel-top type, or three- or four-gallon capacity, is probably the most convenient device to use.

A typical poison ivy vine on a tree. The picture was taken following a killing autumn frost.

It can be carried from the shoulder by a strap or in either hand by the handle.

What chemical should be used? Several have been recommended. The author has tried some of these with indifferent results. However, quite good results have been secured by the use of a brush killer composed of 2,4-D and 2,4,5-T esters. The manufacturer's directions should be followed.

A relatively new weed killer, aminotriazole, was praised in a column in the October, 1956, issue of *Better Homes and Gardens.* It apparently has some selective effect, killing poison ivy but not highway plantings of Japanese honeysuckle infested with the ivy. However, aminotriazole is being used on farms as a general weed killer against such noxious weeds as Canada thistle. If used against poison ivy in a wooded area, it probably would kill most of the other species contacted. This is true of all of the common weed and brush killers.

The author looking at poison ivy that had been sprayed one week before. Plant at lower left was not sprayed.

Selective spraying by hand will enable one to eliminate most of the poison ivy without destroying many other plants. Care must be used, however. A number of other plants superficially resemble poison ivy and may be inadvertently sprayed. Watch for the tick-trefoils (*Desmodium* spp.), raspberries and blackberries (*Rubus* spp.), wafer ash (*Ptelea trifoliata*), bladdernut (*Staphylea trifolia*), box elder (*Acer negundo*), and seedlings of hickories (*Carya spp.*). Particularly difficult to avoid are seedlings of various oaks (*Quercus* spp.). They are often hidden beneath the ivy and many may be destroyed. Large-scale killing of the tree seedlings may very well modify the future composition of the forest.

When should the spraying be done? The plants can be killed anytime while they are in foliage, and the time may be selected to suit the convenience of the worker. Some authorities recommend the month of August.

Personal experience has shown that August is a good time if there is adequate rain and the plants are quite green. In one dry summer, however, spraying late in August was rather ineffective, for the leaves were wilting and dropping.

There is one marked advantage of late summer spraying. Most of the spring flowering plants have completed their growth and disappeared. Thus there is less likelihood of destroying many valued species.

If there are many deer in the forest area, they may have done considerable browsing upon the poison ivy leaves by late summer. Observation has revealed that they eat the leaf blades, leaving the petioles. Such denuded plants can scarcely be killed by spraying. They will produce new leaves, often in the same year.

It isn't fun. Summer work in the woods has its discomforts and hazards. One soon becomes decorated with hitch-hiking seeds. Many thorns and prickles seem to reach out to wound the passerby. Raspberries, blackberries, gooseberries, green briar, prickly ash, hawthorns—all may do damage to clothes and skin. Particularly insidious are the prickles of

the green briar. They may break off in the flesh causing considerable irritation and sometimes remaining hidden for several weeks. Stinging nettles may also stimulate the unwary.

The Arthropods provide their share of discomfort. Much of the time, mosquitoes are intimate, so the worker should always carry a repellant. Occasionally one blunders into a nest of wasps or hornets. Ticks may seek a meal. Chiggers are an ever-present threat.

One should protect himself against chiggers before venturing forth. Flowers of sulfur dusted inside the clothing is a good preventative of chigger infestation. Even more effective, and less objectionable, is Benzylate Lotion rubbed on the skin, especially around the waist, knees, and ankles. This material is secured from druggists by prescription. Its use followed by a hot shower at the end of the working day will prevent most chigger annoyance.

The worst hazard of all is ivy poisoning. Susceptible persons know full well its discomfort. But even such a person can work in poison ivy all day with impunity if he follows certain precautions. Do not touch the plants with bare skin. Keep arms and legs well covered. Wear heavy socks, for the poison may penetrate through thin garments. Avoid touching the clothes or shoes where they have come into contact with the plants, and keep the hands away from the face. At the end of the day, put all clothes into the laundry and take a hot shower with plenty of soap. Incidentally, warn your laundress, or she may be put out of action!

These annoyances, plus summer heat, and an occasional stick or bug in an eye, make poison ivy spraying unattractive to the faint of heart. Only a confirmed "nature lover" will enjoy the occupation!

Effectiveness. How effective is spraying? If the leaves are apparently all killed, is the whole plant dead?

One of the photographs shows a young man spraying a prolific patch of poison ivy at the junction of woodland paths. This picture was taken in 1952. Each of the following three years poison ivy reappeared, and it was again sprayed. Examination of the area in 1956 showed that it was almost completely barren from repeated spraying and compacted from the feet of hikers, yet a few isolated sprouts of poison ivy were still growing.

Another prolific patch has been carefully observed. A lowland area about one hundred feet in diameter was densely populated with a nearly-pure stand of *Rhus* about four feet tall. It was growing in the deep shade beneath sugar maple trees.

This area was sprayed heavily in 1953 and again in 1954 and 1955. In the summer of 1956, there were still scattered living sprouts. Were they new seedlings, or were they growing from the old underground structures? The old dead stalks were still standing, so it was easy to pull on them. This up-rooted horizontal stolons many feet in length. Attached to some of them were living shoots making a valiant comeback after three successive years of attack. It is obvious that much *Rhus* reproduction is vegetative, and that the underground structures are not easily killed. Also, new seedlings appear in previously sprayed areas.

What is the effect of spraying and cutting upon seed production? The seeds are produced in dry berry-like fruits late in the summer. Will cutting or spraying as late as August prevent the maturing of the seeds? The author has been unable to induce germination in seeds collected two weeks after the parent plants were killed by each of the methods. The seeds were left out-of-doors until December to permit after-ripening.

These results are inconclusive. A detailed study of the germination requirements should be undertaken. Although this may have been done, no reference to it has been discovered. Such a study would make an excellent project for an ambitious high school student of biology.

There is considerable evidence from the distribution of poison ivy along fences and in shrubbery that birds play a large role in seed dissemination. Is passage of the seed through the alimentary canal of the bird necessary to germination? This is doubtful, but it merits investigation.

It is evident that poison ivy can be eradicated from limited areas. However, it requires persistent effort for several years to completely free a site from this very objectionable plant.

Scorpions for Laboratory Study

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The class Arachnida, although a large and important biological group, is given little or no consideration in the laboratory work of most general zoology and biology courses. This is primarily due to the fact that the spiders are usually suggested as the laboratory animal of choice. Spiders are relatively difficult to get in large numbers and are quite fragile in the manipulations of beginning students.

Scorpions make excellent laboratory animals. They very clearly show the Arachnid characteristics and are excellent for the study of the water-terrestrial evolution. In certain seasons they can be collected in relatively large numbers, preserve readily and are far less fragile than spiders. The following laboratory exercise, somewhat modified, is one that we have used for a number of years, both in general biology and zoology.

PHYLUM ARTHROPODA
CLASS ARACHNIDA: THE SCORPION

Scorpions are found in about three fourths of continental United States. Although they are generally thought of as desert animals you will find that in arid regions they seek cool, damp habitats. They may be found under boards, lumber piles, brick piles of various types, among old trash, burrowed in sand, and in human dwellings. In the United States we find that the majority of scorpions will actively burrow into sand and loose soil seeking shelter and dampness. A relatively small genus, the *Centruroides*, however, does not burrow but prefers to hide in the crevices of loose bark, stones, lumber and in human dwellings. All scorpions have venom secreted by glands found in the bulbous end of the "tail." The venom of most species produces only a local reaction at the site of the sting and is characterized by a burning sensation more or less painful, a swelling and possibly discoloration. Two species found mainly in southern and central Arizona have a venom that does not produce a swelling but affects the nervous system. This state's vital statistics show that they have been responsible for more than twice as many deaths than all other venomous animals together.

The scorpion, like the crayfish, is an Arthropod, but it belongs to the Class Arachnida and the Order Scorpionida. Since the scorpion and the crayfish belong to the same phylum they must have certain characteristics in common.

1. What are they?
2. (a) What are the characteristics that make the scorpion a member of the Class Arachnida?
   (b) Name three other kinds of animals that are members of this class.

   The body of the scorpion is covered with an exoskeleton of chitin (ki'tin) secreted by the layer of cells just beneath it.
3. (a) What makes it possible for the scorpion to move the various divisions of its body?
   (b) What must a scorpion apparently do before it can increase in size?

Examine a baby scorpion. Note how soft its body is and how weak its various appendages are in contrast to the tough and hard covering of an adult.

4. What would you logically conclude as to the possibility of the *baby* scorpions eating the mother, a belief held commonly by many people?

The scorpion body is divided into a series of segments which are grouped into two major areas: (1) the *cephalothorax*, and (2) the *abdomen*. The latter is further divided into the *preabdomen* and *postabdomen*. Frequently, the cephalothorax and preabdomen are spoken of as the *trunk* and the postabdomen is called a *cauda* or "tail." Other terms sometimes used are *prosoma* for the cephalothorax, *mesosoma* or *abdomen* for the preabdomen and *metasoma* for the post abdomen. Collectively, the mesosoma and metasoma constitute the *opisthosoma*.

The cephalothorax is the most anterior division of the body. Ventrally six segments are clearly indicated by the six pairs of appendages, but from the dorsal aspect we see only a

single fused chitinous plate, the *carapace*. In the anterolateral angles are located the lateral eyes in groups of two, three or five, depending on the species. A few species groups lack lateral eyes entirely.

5. How many are there on each species examined?
6. Are they arranged in a curved or straight line?

In the middle of the carapace, usually a little forward from its center are two large *median eyes* situated on the sides of a small convexity, the *ocular tubercle*. The somewhat triangular area outlined by the three groups of eyes is called the *ocular triangle*.

The ventral surface of the cephalothorax is covered by the *coxae* in the form of *coxal plates* and two pairs of *maxillary lobes*, and by a characteristic central plate, the *sternum* and which is of taxonomic importance. This plate may be in one of the following shapes:

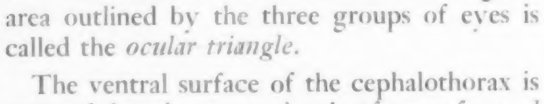

Figure 1A

7. Between what pair of leg coxae is it found?
8. *Make a careful proportioned outline drawing of the sternum of each of your three specimens. Do not make hasty conclusions as to the shape because the convexities of the surface make the total sternal area somewhat deceiving in appearance.*

The following six pairs of appendages arise from the cephalothorax; the *chelicerae* (ke-lis'-er-a), the *pedipalps* (or pinchers or chelipeds), and the four pairs of walking legs.

The chelicerae, the three-segmented, relatively small pincher-like appendages with shearing jaws, are located anteriorly and partly concealed beneath the anterior border of the carapace. These are used for tearing the food (soft bodied insects, spiders, etc.) into minute bits. With forceps carefully remove a chelicera from one of the specimens.

9. *Complete the following outline drawings of the superior surface of one or more chelicerae.*

Figure 1B

The pedipalps are composed of six segments: the *coxa*, the most proximal joint, next the *trochanter*, *humerus* (femur), *brachium* (tibia), and the *hand* or *chela* which consists of the *palm*, the *fixed finger* and the *movable finger* or sixth segment.

On the cutting edge of the pedipalps will be found many small teeth, the *supernumerary teeth*, flanked occasionally by larger teeth.

10. Are these small teeth arranged in a single continuous row or a single discontinuous row, or a number of oblique rows?
11. If they are oblique, how many of these oblique rows are there?

On the pedipalps are found some very interesting hair-like organs called *trichobothria* which are made up of long, slendar bristles, each located in the center of a circular depression surrounded by a bright convex ring.

12. How many do you find on the ventral surface of the humerus of each of the scorpions examined?
13. What function would you suggest for these trichobothria?
14. Draw a *trichobothrium*.

The four pairs of walking legs are composed of the following eight joints: *coxa*, the most proximal joint, then the *trochanter*, *femur*, *patella*, *tibia*, *protarsus*, *tarsus* and *epitarsus* with its claws. Maxillary lobes are found protruding anteriorly from the coxa of the first two pairs of legs. For taxonomic purposes the following structures on the legs are of importance:

a. The presence or absence of a thorn-like structure, the *tarsal spur* on the *articular membrane* between the *tibia* and *protarsus*.

15. Do your specimens have these structures? Make sure of your observation. (Is the thorn-like projection on the *articular membrane?*)

b. The presence of an exterior tarsal spine or of both an interior and exterior spine.

called the *pedal spurs* (grunddorn or espina tarsal), in the *articular membrane* between the protarsus and tarsus.

16. Do your specimens have pedal spurs? The spine may have small spinelets. Is the one you see on the *articular membrane*? How many on each leg?

The abdomen of a scorpion consists of twelve segments: seven in the preabdomen and the remaining five, plus a postanal segment called the *telson*, making up the cauda or "tail." Observe carefully that the *anus* is located at the ventroposterior end of the fifth postabdominal segment. Why is it technically incorrect to refer to the cauda as a "tail"? This post-anal segment consists of a swollen portion, the *vesicle* (or ampulla), which contains two poison glands, and the *aculeus* (or stinger). Careful microscopic examination will reveal two small orifices, the *venom apertures*, near the aculeus tip and leading into the ducts coming from the poison glands. At the base of the aculeus, in some species, may be found a small protuberance in the form of a tubercle or peg-like tooth, called a *subaculear tooth* or *tubercle*.

17. Do any of your specimens have a subaculear protuberance? Is it in the form of a tooth (pointed) or tubercle (blunt)?
18. *Make an outline drawing of the lateral aspect of the fifth postabdominal segment and the telson of the specimen bearing a subaculear protuberance*. Show and label the (1) anus, (2) the shape of the venom apertures, (3) the vesicle, (4) the aculeus, and (5) a subaculear tooth.

The last five segments of the preabdomen are clearly visible on the ventral surface in the form of broad plates or *abdominal sterna*. Abdominal segments III to VI each bear a pair of *stigmata*, the openings to the respiratory organs or *lung books*, represented externally by the lighter colored areas anterior to the stigmata.

19. Are the stigmata oval, round, or slit-like?

The *genital aperture* is found on the inferior face of the first abdominal segment and is covered by an anteriorly hinged plate, the *genital operculum*.

Although sexual dimorphism exists among the scorpions, there are no characters consistently constant to differentiate male from female of all species. The secondary sexual characteristics are largely species specific.

The most common sexual characteristic is the comparative lengths of trunk and cauda. The male frequently has a shorter and narrower trunk while the "tail" may be longer than that of the female. When this is the case the individual segments are longer than those of the female; especially caudal segments IV and V. Generally with the lengthening of the "tail" goes a narrowing of the segments, so that the entire male has the appearance of a much slenderer and more graceful animal.

On the female of some species the genital operculum consists of one piece but grooved medially, while in others both sexes have the plate actually divided into longitudinal halves thus facilitating the projection of the *genital papillae*, two tiny protrusions, one on each side of the genital aperture, found on the male of *some* species. In many species the papillae extend slightly beyond the medo-posterior margin of the genital operculum.

22. Do your specimens possess these papillae?

In some species the telson bears secondary sexual characteristics. The shape of the vesicle when viewed laterally is found to be more globular in the female. In other species when viewing the vesicle from the dorsal aspect, shows it to be more pointed distally in the male, while the lateral view shows a very slight difference, if any, in contour. The granulations of the vesicle frequently are different in the sexes; the female often having coarser granules.

The *pectines* (pecten, sing.) or "combs," characteristic sensory organs found only on scorpions, often assist in recognizing the sexes. These curious little structures are located on the ventral face of the second abdominal segment. The posterior margin of each "comb" is flanked with elongated structures or *teeth*, at the base of which are the somewhat triangular-shaped pieces called *fulcra*. The posterior margin of each pectine is made up of laterally elongated plates, called the *anterior lamellae*. Between these and the fulcra are found the *middle lamellae*. These may be irregular in shape or appear as a row of small spherical or bead-like plates. In some species the pecten teeth vary in length and number in the two sexes. Frequently the teeth of the

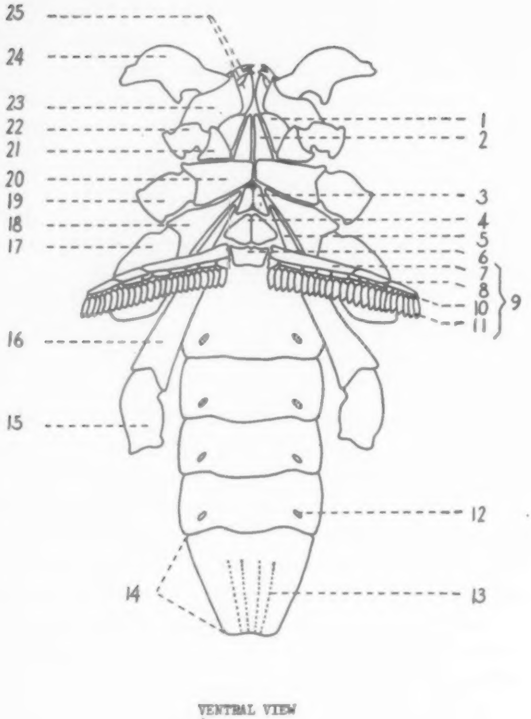

Figure 2

male are longer and more numerous than those of the female.

23. What is the shape of the middle lamellae of your specimens?
24. How many teeth on each pecten of each specimen? Indicate pecten as right and left.
25. *Using the following key to the families of scorpions determine the family to which each of your scorpions belong.* Copy, in the order of the key, those characteristics that you used in determining the family name of each scorpion. Follow the last characteristic with the family name in each case.

1. a. Sternum at least half as long as broad; frequently, however, longer than broad............ 2
   b. Sternum made up of two small, transverse plates, sometimes scarcely visible, several times broader than long. (Fig. 1A)....BOTHRIURIDAE
2. a. One or two pedal spurs on the exterior and interior sides of the legs. The sternum is frequently narrowed anteriorly... 4

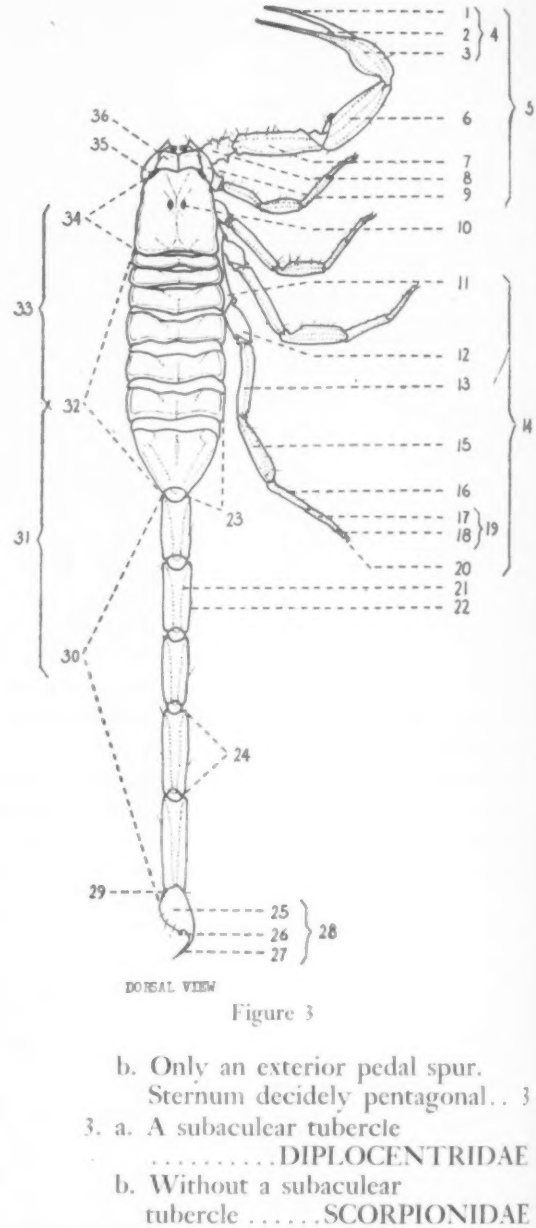

Figure 3

   b. Only an exterior pedal spur. Sternum decidely pentagonal.. 3
3. a. A subaculear tubercle ..........DIPLOCENTRIDAE
   b. Without a subaculear tubercle ......SCORPIONIDAE
4. a. Three to five lateral eyes on each side 5
   b. Only two lateral eyes (seldom none) ...CHACTIDAE
5. a. Sternum subtriangular, very rarely pentagonal (then the third and fourth pairs of legs have a tarsal spur). Middle lamellae of pectines never like a row of little pearls; lateral eyes three or five; often a subaculear tooth ......BUTHIDAE

b. Sternum with parallel or almost parallel lateral sides, broader than long, with a deep median groove; middle lamellae of pectines frequently formed like a row of little pearls. Always only three lateral eyes. Without tarsal spur ....VEJOVIDAE

The internal anatomy of the scorpion will not be studied.

Identify the structures on the dorsal and ventral aspects of the scorpion as indicated on the two outline drawings given you by your instructor.

Carcinogenesis and Tumor Growth

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In 1916 two Japanese scientists discovered that it was possible to produce tumors in experimental animals by administering chemical substances of coal tar.

The method of artificially producing tumor growth is termed carcinogenesis. The particular agent used to incite tumor formation is called a carcinogen or carcinogenic substance. The precise mode of induction of malignant tumors by carcinogens is not completely understood, but the effect is probably intimately associated with the enzymatic constitution of the cell.

Of the numerous chemical carcinogens, e.g. benzypyrene, diabenzanthrene, methycholanthrene, etc., methycholanthrene, because of its ready availability and its very high carcinogenic effectiveness, is the carcinogen most frequently used to produce malignant growth.

Chemically induced cancer in rats

A carcinogenic solution of methycholanthrene is prepared as follows: 500 mg. of methycholanthrene is dissolved in 50 cc. of either sesame oil or olive oil. (The oil functions as a carrier and increases the incidence of malignant tumor growth when it is applied with a carcinogen.) This solution is kept in a serum bottle at room temperature.

Once a week one cubic centimeter of this solution is injected subcutaneously and very superficially into the lower abdomen of a rat. This procedure is repeated until tumor growth is evidenced by the appearance of a nodular growth at the site of injection. This period of injection may be three months or more. When the tumor is well established transplants should be made to other rats of the same species.

Tumor Transplantation

In most laboratories tumor tissue is maintained in stock rats. When experiments are to be made, transplants are made to the rats to be used in the experiments. If one is testing tumor inhibitory substances, the experiments are set up using animals with tumor transplants and the substance to be tested. The controls consist of animals that have received transplants but not the substance to be tested. At the termination of the experiment the animals are sacrificed, the tumors excised and the weights of the tumors from the two groups of animals are compared. The tumor tissue is checked for necrosis and other effects are ascertained.

Two methods are primarily used for making transplants of tumor tissue from one animal to another: the implantation technique in which relatively large pieces of unminced tumor tissue are inserted into subcutaneous incision in the abdomen of the rat; the injection technique in which minced tumor tissue is injected with a hypodermic syringe, subcutaneously, into the abdomen of the rat.

When transplants are to be made they are made to animals of the same species as the donor rat. The recipient rat should weigh between 110-175 grams if maximum growth of tumor is to be obtained.

The donor rat is quickly and painlessly killed. The skin covering the tumor is slit and pulled back to expose the tumor. A part or all of the tumor is excised. The tumor is then put into a flat dish which contains a sterile saline solution. If the implantation technique is to be used the tumor tissue is cut into pieces

about 1-3 mm. square. If the injection technique is to be used the tissue is minced for use in a hypodermic syringe.

Implantation Technique

The recipient rat is anesthetized and the region of the lower abdomen is shaved. An incision large enough to receive the tip of a small probe is made in the epidermal layer of tissue. A sterile probe is inserted in the opening and the epidermal tissue layer is separated from the tissue that protects the abdominal cavity.

A piece of the tumor tissue is held against the tip of a small sterile pipette by gentle suction. The tip of the pipette is thrust deeply into the opening and the tumor tissue is expelled by positive pressure. This procedure is repeated until three or four pieces of tumor tissue have been implanted. The incision is then sutured. Care must be taken at all time during this procedure to see that relatively sterile conditions are maintained.

Injection Method

The minced tissue is placed in a hypodermic syringe. A 12-gauge needle is used in conjunction with the hypodermic syringe to inject the tumor tissue subcutaneously into the abdomen of the rat. This technique has the advantage over the former in that there is less chance for infection to occur.

The tumor transplants, after a latent period of several days, will begin to grow avidly. By the end of eleven to fourteen days the rat will succumb to the effects of the tumor growth.

Note: Methylcholanthrene and other carcinogens can be obtained from the Eastman Organics Department of Distillation Products Industries, Rochester 3, N. Y.

Animal Cell Division

One of the key steps leading to the division of animal cells has been isolated for study in the test tube by bio-chemists at New York University. This means they can examine the step—known as cytoplasmic gelation—more closely than ever before, specifically on the scale of molecules, nature's complex architecture of individual atoms. It has been known for several years that gelation if the clustering, or sticking together, of molecules. It occurs during a change in the electrical charge on the molecules.

Use of the Microprojector to Make Photographs of Slides

MELBA L. JAMES
Riverview Gardens High School
St. Louis, Missouri

Have you ever wanted a nice 8 x 10 photograph of microscopic slides? Well you can now make them yourself with as little time, effort, and know how as it takes to dial a phone!

This summer while attending Indiana University I took a course in Improving Science Teaching with Prevo L. Whitaker. We were assigned to do a project which we could take back to our schools this fall and use. Since I had access to a microprojector I decided to learn how to use one. The next thing I knew I was trying to photograph the projected slide. At first I made a negative by photographing the projected slide but this involved too much time and much of the detail was lost. Next I tried to find direct positive paper but it seems the shops hadn't had any in months. Besides the processing of this type of paper is long and rather complicated. So I tried Kodabromide No. 3—it worked beautifully and cost only 14 cents a print!

Materials Necessary:

- Microprojector
- Good microscopic slides
- Darkroom
- 3 or 4 trays
- Developer (Kodak Dektol, 35 cents per box)
- Hypo-fixer (Kodak Photo Fix, 35 cents, quart size)
- Photographic Paper (8 x 10 Kodabromide No. 3, $2.30 for 25 sheets)
- Cloth (heavy dish towel)
- Blotter book or small photographic print dryer
- Yellow photographic safe light (red light optional)

Procedure:

Mix up chemicals as directed on the package. Other brands may be substituted, as I merely listed those that I used. The developer will last only a few days at the most, but the hypo is good for several months. Arrange trays in the following order: developer, water

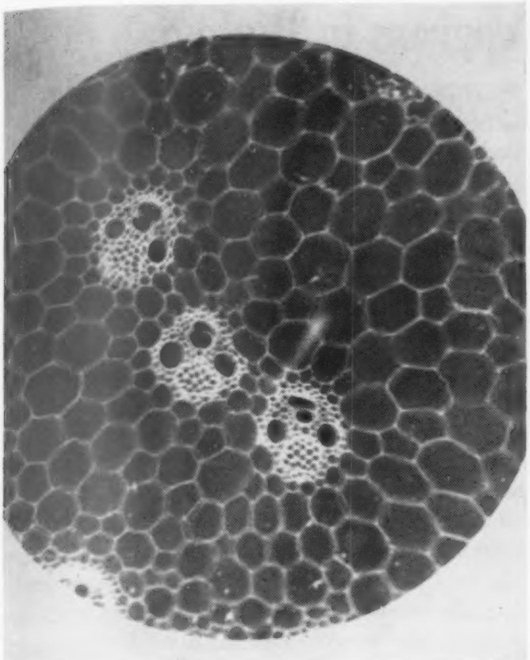


Figure 1. Vascular bundles of the monocot *Zea*.

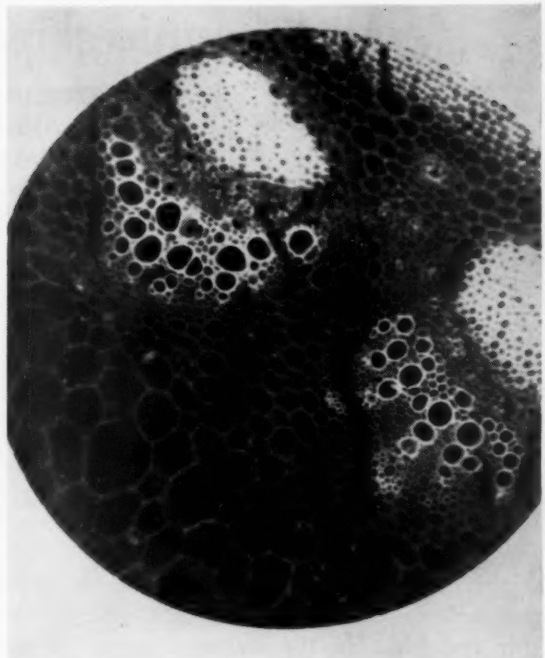


Figure 2. Vascular bundles of the dicot *Helianthus*.

short stop (optional but will help the hypo last longer), hypo, and water wash. Set up the microprojector and focus the slide vertically on a piece of white typing paper. The microprojector that I used was a Ken-A-Vision and the area between the legs is about 10 inches. Be critical in the selection of the slides so that the subject is well stained and distinct. Place a cloth over the light source and tuck it under the stage. You should notice when doing this that the field of projection is darkened and a definite circle is formed. This cloth is the secret of the process because it eliminates the diffusing light at the edges of the projected image and maintains even lighting over the field. When the slide is in good focus and arranged as desired, turn out all the lights. A small voltage photographic red light could be left burning if available. Slip the photographic paper with the slick side facing upwards on top of the typing paper used for focusing. This paper's emulsion is extremely fast so click the microprojector on and then off immediately. The time of exposure should be increased as the image is increased in magnification. Remove the paper and place it in the developer. A photographic yellow light is necessary for this and the following steps. A good print develops in about 1½ minutes. If the print appears quickly and immediately turns black, you have exposed the paper too long. If the print comes up very slowly and fails to develop completely, the exposure was too short. The print will look lighter in natural sunlight than it does under the yellow light and consequently should look *slightly* too dark when removed from the developer. Don't leave the print in the developer more than 2 minutes. If you used a water short stop, merely place the print from the developer into it for a minute and then transfer into the hypo. Hold the print up and allow to drain before transferring from one tray to the next. The print should remain in the hypo from 3 to 10 minutes. The length of time depends on the age of the hypo. After this it is placed in the tray of running water to wash for 45 minutes. Now the lights may be turned on. The prints are dried in a blotter book or photographic print dryer upon removal from the wash.

Actually the time necessary to print, develop and place into the hypo takes as little time as it takes to read this article. One doesn't have to be an accomplished photographer to have 100% success. The major factors are the careful selections of slides, the cloth over the microprojector and the click-click to expose the photographic paper.

An Apprenticeship Program in Biology

KENNETH E. HUTTON
Instructor, Department of Zoology
Tulane University

The zoology and botany departments of Tulane University are initiating a program which perhaps is unique in its approach and organization. An "Apprenticeship Program" is being organized which, it is hoped, will attract and stimulate some of the scientific interests of incoming college students—interests which often become lost due to lack of orientation and direction.

It is not uncommon for a college biology instructor to be told by an advanced student that he enjoyed biology in high school and might have gone into the biological sciences had he known what opportunities were available and what the requirements were. To be sure, interests of the young student usually involve the collection of insects, the capturing and raising of pet animals, or similar hobby-oriented subjects. But these simple interests may develop into a career in science if they are given the proper encouragement and guidance. Considering the present and forthcoming need for biological scientists, Tulane is implementing a program designed to locate and nurture these interests.

Under the program, an apprentice will be an undergraduate student who has stated that he would like to devote at least four hours a week to working on a biological topic which interests him. Both laboratory and field work will be available. His work will be under the direction of a faculty member with whom he must confer at least once each week. His choice of faculty-member director will depend upon his interests. Furthermore, other activities within the departments—such as seminars—will be available to him.

The student applying for the apprenticeship must not necessarily have decided to make the biological sciences his major field of study while in college. Naturally, it is hoped that if he has the talent he will so choose. Apprenticeships are awarded on a one-year basis and are subject to renewal.

The opportunity to develop his interests is the only reward the apprentice will receive. In short, he will receive no money. However, he is encouraged to apply for a scholarship. It is assumed that if he is a good enough student to be accepted into the apprentice program, he should have little trouble receiving a scholarship.

Information to prospective apprentices is being disseminated in several ways. A printed announcement suitable for posting on a bulletin board is being mailed to the biology teachers in a number of high schools throughout the country. Verbal announcements regarding the program will be made at science fairs in Louisiana and neighboring states. Individual teachers may be interviewed if this seems desirable. Many teachers, of course, will become familiar with the program through this article.

Normally the apprenticeship application will be received by the University accompanying the application for admission. *The deadline for application is April 1st.* A three-man committee will be notified by the Director of Admissions of receipt of the application. This committee will have at its disposal all the records of the Director of Admissions—including references and decisions regarding scholarships. The committee's decision regarding the individual applications will be made by May 30th.

The program will undoubtedly be altered in the future as the departments gain experience in its administration. However, it is felt that this and similar programs have a great potential value in increasing the number of college students desiring to make the biological sciences their career.

Anyone interested in receiving a copy of the announcement poster and/or an application form may obtain these by writing the Director of Admissions, Tulane University, New Orleans 18, Louisiana.

A Film Impression Method for the Observation of Minute Features of Wood Anatomy

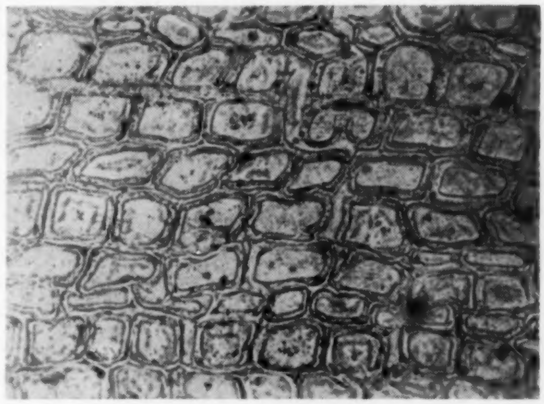
H. O. BEALS
Graduate Student, Purdue University

The use of nitrocellulose film impressions or peels in geology, metallurgy, and related fields for surface texture study has been known for many years. Recently, improved techniques and materials have been developed for surface study of machined metal surfaces in industry. One of these is a cellulose acetate film kit formerly manufactured by the Brush Electronics Company, Cleveland, Ohio, under the name "Faxfilm."

The "Faxfilm" kit, no longer on the market, is made up of two parts. One part is a cellulose acetate ribbon ¾" wide by .005" thick by 400" long, while the other part is a solution made by dissolving 20 inches of this film in two ounces of acetone. A cellulose acetate film which meets these specifications is manufactured by Monsanto Chemical Company under the name "Vuepak F" and is available in sheet or slit roll form.

The usual method of making nitrocellulose, cellodin, or other similar peels, is to prepare a solution of nitrocellulose in a suitable solvent, which is then brushed or poured on the surface to be examined. Then the solvent has evaporated, the film is peeled or stripped from the surface and examined under the microscope. When this technique is used on wood, the lower surface of the exposed elements lie too deeply for the film to contact them, and air bubbles develop during drying. However, by using a film and solution combination, such as "Faxfilm," it is possible to pick up detail to much greater depths than is possible with thinner peels.

A cellulose acetate impression of longitudinal wood surfaces will produce replicas, in reverse, of certain wood elements which can be used for positive identification of the specimen without the preparation of freehand sections. These replicas can be examined microscopically at magnifications to 450x. Only those elements showing wall sculptoring such as simple or bordered pits, vessel member perforation plates, or spiral thickening can be clearly observed. Those elements that do not contain such sculptoring will appear as indistinguishable masses.



Photomicrograph (150x) of petrified Ponderosa Pine from Montana, estimated age—30 million years. The mineral opal has replaced the woody tissues of the pine. Section prepared by the author.

Most woods need very little preparation except to provide a split or smoothly planed surface which is free from foreign matter. A few woods require filling in order to provide a base for the film. A simple method of filling is to apply several drops of Canada Balsam on the area to be examined and place the specimen in an oven at about 180°-200° F. over night. When the resin has been properly cured, it will be very hard and very brittle with no trace of tackiness. Scrape the filled wood with the edge of a glass slide until the surface is smooth and somewhat polished. Remove the resin by etching with several applications of xylene and successive film impressions until maximum detail can be observed.

To make an impression, cut a piece of the cellulose acetate ribbon about one inch long from the roll. Apply a drop or two of light oil to the surface to be inspected and rub it in

thoroughly with the finger tip. On either the wood surface or the ribbon, place one or two drops of the cellulose acetate-acetone solution, being very careful not to get any of the solution on top of the film, and press the film firmly onto the oiled surface. With a soft rubber eraser, press out the air bubbles, but do not slide the film, and maintain pressure for about 15 seconds. Let the film dry from one to several minutes until the solvent has completely evaporated so that air bubbles are kept to a minimum during the peeling process. When the film is completely dry, peel it back from the wood surface by grasping one end of the film and pulling gently.

The film is best observed through the microscope by mounting it on a slide, with the impression side up, by means of a strip of masking tape with a hole in the center. This will hold the film flat against the surface of the slide and the part to be viewed will be visible through the hole in the tape.

This method of using cellulose acetate film replicas of wood surfaces for purposes of wood identification in substitution of free hand sections offers several advantages, principally in speed and ease of application. It has several disadvantages in that complete surfaces cannot be observed, but only isolated elements or fragments are visible for study. Replicas of transverse sections are not practicable by this process except for use at very low magnifications.

REFERENCES:

1. Twenhofel, W. H., and S. A. Tyler, *Methods of Study of Sediments*, McGraw-Hill Book Company, New York, 1941, p. 170.

PLANTS WITHOUT FLOWERS. Bastin, Harold. Philosophical Library Inc., New York 16, N. Y. 146 pp. 1955. $6.00.

This book is designed to give the reader some glimpses of a less familiar but equally enthralling section of the Plant Kingdom in which flowers are entirely absent. Mr. Bastin proceeds to trace the evolutionary ascent of flowerless plants through algae or seaweeds, fungi, and mosses to the ferns, horse-tails and club-mosses. His style is pleasantly readable, and the matter, while scientifically sound, has been kept as free as possible from technical jargon. An important part of the book is its excellent photographs.

Regional Consultants on Science and Mathematics Teaching

A.A.A.S. SCIENCE TEACHING IMPROVEMENT PROGRAM

In order to meet more effectively the goals of the Science Teaching Improvement Program (STIP) of the American Association for the Advancement of Science (AAAS) during the coming year, a plan for regional consultants in science and mathematics to serve colleges and universities has been established. The consultants will be available to visit colleges and universities in their areas upon invitation by the institutions. In accepting responsibility for this work, the 20 consultants will actually be additions (without compensation) to the staff of STIP which will pay travel expenses and a small allowance for secretarial help. The schedule of visits will be the responsibility of each consultant. This regional consultant service has been made possible by a grant to AAAS from the General Electric Educational and Charitable Fund.

STIP is an action program to increase the number of well-qualified science and mathematics teachers at the secondary-school level. In order to carry out STIP, the cooperation of scientists in all parts of the country must be obtained. Success will depend to a considerable degree upon decisions and activities on a local basis. During the first year of operation, representatives of STIP presented the program to scientists on 50 college and university campuses, in state and regional meetings called by STIP, and at meetings of 12 state academies of science, as well as other professional scientific societies. In these travels many good suggestions were obtained; counsel was given on the development of local projects, and cooperation sought in the attainment of STIP objectives. The frequent suggestions that visits to a campus from a representative of a national scientific society can be of value in the stimulation of local activity has resulted in the project for regional consultants. In calls upon colleges and universities the consultants might:

1. Meet with staff members in education and science jointly to consider problems of science and mathematics teacher education. It would be desirable in these conferences if at least one representative of the state department of education could also be present, and possibly also secondary-school teachers.

2. Suggest ways in which colleges and universities might maintain closer working relationships with science and mathematics teachers in secondary schools.

3. Review possibilities for achieving greater awareness of the need for strong programs in science and mathematics, on the part of the general public, school boards, and school administrators.

4. Take part in the discussion of programs to interest more young people in the study of science and mathematics, and the preparation for careers in science, engineering, and teaching.

5. Seek information about promising programs which can be shared with other consultants and with the STIP office.

6. Discuss ways in which the AAAS, through STIP and other activities, may be of assistance in the improvement of science teaching.

REGIONAL CONSULTANTS

1. *New England*
   Albert G. Olsen (Biology), Brandeis University
2. *New York*
   Lowell D. Uhler (Biology), Cornell University
3. *Pennsylvania, New Jersey*
   Marsh White (Physics), Pennsylvania State University
4. *Virginia, West Virginia*
   E. J. McShane (Mathematics), University of Virginia
5. *Maryland, Delaware, District of Columbia*
   I. E. Wallen, Asst. Dir., STIP (on leave-Zoology-Oklahoma A&M College)
6. *North Carolina, South Carolina*
   Walter M. Nielsen (Physics), Duke University
7. *Georgia, Alabama, Florida*
   Russell H. Johnsen (Chemistry), Florida State University
8. *Ohio, Michigan, Indiana*
   A. B. Carrett (Chemistry), Ohio State University
9. *Wisconsin, Minnesota*
   Kenneth O. May (Mathematics), Carleton College
10. *Illinois, Missouri, Iowa*
    Jerry J. Kollros (Zoology), State University of Iowa
11. *Kentucky, Tennessee*
    F. Lynwood Wren (Mathematics), George Peabody College for Teachers
12. *Mississippi, Arkansas, Louisiana*
    Houston Karnes (Mathematics), Louisiana State University
13. *Nebraska, Kansas*
    G. Baley Price (Mathematics), University of Kansas
14. *Montana, North Dakota, South Dakota*
    Adrien L. Hess (Mathematics), Montana State College
15. *Oklahoma, Texas*
    Joe P. Harris, Jr. (Biology), Southern Methodist University
16. *Colorado, Wyoming*
    Burton W. Jones (Mathematics), University of Colorado
17. *New Mexico, Arizona*
    M. G. Seeley (Chemistry), University of Arizona
18. *Utah, Nevada*
    Melvin C. Cannon (Chemistry), Utah State Agricultural College
19. *Washington, Oregon, Idaho*
    E. G. Ebbighausen (Physics), University of Oregon
20. *California*
    Norman A. Watson (Physics), University of California (Los Angeles)

Biology in the News

BROTHER H. CHARLES, F.S.C.
St. Mary's College
Winona, Minn.

LIVE WITH YOUR NERVES AND LIKE IT, Walter C. Alvarez, M.D., Cosmopolitan, Feb. 1957, pp. 40-45.

Nervous disorders are the fruit of our present speed of living. This article points out methods of mental conduct which the young can cultivate and thus avoid becoming one of the ever increasing number of wrecks who flock the doctor's office.

WHO SHOULD GUARD YOUR FAMILY'S HEALTH? Perry Rogers, Beth Day, Cosmopolitan, Feb. 1957, pp. 46-47.

Two provocative articles discussing whether the family doctor or a group of specialists should care for the general health of the family.

REMEDY FOR DEATH, Jack Connor, Outdoor Life, Dec. 1956, pp. 56-59, 95.

Minnesota's method for preventing accidents with guns during the hunting season. A fine article for anyone's safety program.

POISON BY THE POUND, Norman Spray, Outdoor Life, Jan. 1957, pp. 26-27, 48, 51, 62-64.

Rattlesnake hunting in Texas is a dangerous sport. An account of a successful hunt under the direction of skillful professionals.

HOW TO HUNT CROWS, Tom McNally, Outdoor Life, Feb. 1957, pp. 30-32, 70-71.

Outwitting the crow is no easy matter. This article might stimulate discussion as to the uses of the crow and the advisability of destroying many of them.

HERBS, Good Housekeeping, Feb. 1957, pp. 96-103.

Suggestions, charts and recipes for the use of herbs in our diets. The active class will make additions to the list and bring specimens.

Conference on Undergraduate Curricula in The Biological Sciences

RICHARD E. PAULSON
Executive Secretary, Committee on Educational Policies

The Committee on Educational Policies and its Subcommittee on College Education, units of the Biology Council, Division of Biology and Agriculture, National Academy of Sciences—National Research Council, are sponsoring a Conference on Undergraduate Curricula in the Biological Sciences. The Conference, which is supported by a grant from the National Science Foundation, held a first meeting at the Woodner Hotel, Washington, D. C., December 8-9, 1956, and will finish its deliberations in a session at the University of North Carolina, Chapel Hill, April 1-4, 1957. Dr. Willis H. Johnson, a member of the Subcommittee, is chairman of the Conference.

Recognition of the need for a major conference on biological curricula arose, in part, from correspondence and discussion between the Subcommittee on College Education and some five hundred American biologists concerning problems confronting undergraduate education as they relate to the biological sciences. Many correspondents emphasized the need for an intensive, critical re-examination of courses and curricula. It is widely felt that instructional programs, conditioned as they necessarily are by history and tradition, have often failed to evolve at a rate commensurate with the present and future demands of, and responsibilities upon, the life sciences.

The broad purpose of the Conference is to develop a set of principles for guidance in planning biological courses and curricula for future biologists, keeping in view the vast range of the biological sciences, knowledge and abilities teachers must help students develop, and the functional and technical requirements of different disciplines and lines of work which biologists enter. Discussion is being centered around three questions, corresponding to the main levels with which undergraduate education is concerned: 1) What biological knowledge should form part of the experience of all or most college students, regardless of their course of study? 2) What additional knowledge and experience, in both biological and related fields, is essential, useful or desirable for all biologists, irrespective of later specialization? 3) What is the role of the undergraduate college in providing specialized training, and what additional elements are basic in each of the major areas of specialization in biology?

A summary report will be published shortly after the April meeting and distributed widely. A detailed account of the discussions will also be issued later during the year.

The Committee invited the following seventeen biologists, representing diverse fields, to participate in the Conference: Marston Bates, Julius H. Comroe, Jr., Lincoln Constance, Harriet B. Creighton, Donald R. Griffin, I. C. Gunsalus, James H. Hilton, George H. Kidder, Chester A. Lawson, John A. Moore, Henry J. Oosting, Robert B. Platt, Alfred S. Romer, I. W. Sizer, Carl P. Swanson, S. L. Washburn, and Frits W. Went.

Others attending the Conference include

L. A. Maynard, chairman, and Frank L. Campbell, executive secretary, of the Division of Biology and Agriculture; Paul A. Weiss, chairman, and Russell B. Stevens, executive secretary, of the Biology Council; Donald B. Anderson of the National Science Foundation; the Committee on Educational Policies—Howard M. Phillips, chairman, H. R. Albrecht, C. H. Bailey, John A. Behnke, Claude S. Chadwick, Thomas S. Hall, Carlyle Jacobsen, Milton O. Lee, and T. S. Painter, members, R. E. Paulson, executive secretary; and the Subcommittee on College Education—Benson E. Ginsburg, Victor A. Greulach, Willis H. Johnson. Because of the importance of their fields for biology, a chemist, a physicist, and a mathematician have also been invited to the second meeting.

Books for Biologists

THE PHYSICS AND CHEMISTRY OF LIFE, Editors of Scientific American, 270 pp., $1.00, Simon and Schuster, New York, New York, 1955.

This book is concerned with life as a physical process. The questions raised here are the kind that can be answered wholly within the disciplines that explain the behavior of non-living atoms and molecules.

ATOMIC ENERGY RESEARCH AT HARWELL, K. E. B. Jay, 144 pp., $4.75, Philosophical Library, New York, New York, 1955.

This book from the United Kingdom Atomic Energy Authority carries forward the story of the Atomic Energy Research Establishment from 1951 to 1954.

FIRST BOOK OF ANIMALS, Editors of Scientific American, 239 pp., $1.00, Simon and Schuster, New York, New York, 1955.

This book is a sampling of the curious and wonderful inventions of life that have always intrigued the human imagination. The questions answered by the scientific investigation described in the book lead straight to some of our most valid and useful insights into the ways and workings of life.

THE NEW ASTRONOMY, Editors of Scientific American, 243 pp., $1.00, Simon and Schuster, New York, New York, 1955.

Today we find ourselves in a cosmos pervaded everywhere with motion and change, which is being explored with new tools and techniques by modern astronomers. This is a book for the general reader who would like to feel more at home in the universe of our times.

ATOMIC POWER, Editors of Scientific American, 180 pp., $1.00, Simon and Schuster, New York, New York, 1955.

This is a book about atomic power. That is to say, it deals with the constructive, beneficial or peacetime uses of energy liberated from the atomic nucleus. The wealth of technology in evidence here is assurance that nuclear fission is ready to take its place alongside fire in meeting the increasing energy needs of mankind.

AUTOMATIC CONTROL, Editors of Scientific American, 148 pp., $1.00, Simon and Schuster, New York, New York, 1955.

This book is a survey of what is currently being done to make it possible for machines to regulate themselves by what is called "feedback"—an old idea and possibly the basis of a Second Industrial Revolution. It is by the means by which we will carry on big business and big government, production, finance, communications, trade and distribution in the civilization of our times.

THE PREVALENCE OF PEOPLE, Marston Bates, 283 pp., $3.95, Charles Scribner's Sons, New York, New York, 1956.

This book inquires first into the topic of men, their numbers, nature, and kinds; then into their means of subsistence; next, logically into human reproduction, and the troubled question of its control; then into the causes of death; and next the very core of the book's problem, the postponement of death. The book is written in an informal conversational style which holds the reader's interest.

THE ANATOMY OF THE MIGRATORY LOCUST, F. O. Albricht, 118 pp., $6.00, University of London, The Athlone Press, 1953.

This is the first attempt to present a single comprehensive account of the external and internal anatomy of the migratory locust. It provides a background for current research and a storehouse of facts; at the same time the book is designed to serve in the teaching of general entomology.

ANTHROPOLOGY, J. Manchip White, 191 pp., $2.75, Philosophical Library, Inc., New York, New York.

The author makes an attempt to introduce the reader to the work performed by the anthropologist in several spheres of inquiry. In this book anthropology is not so much the study of man as it is the study of primitive man.

BACK OF HISTORY, William Howells, 384 pp., $3.50, Doubleday and Company, Inc., Garden City, New York, 1954.

This book deals with the history of man, not with the written history of man living in cities but with the evolutionary history. In studying the full history of man, you become aware that there is no real line between biology and history.

THE MICROPHYSICAL WORLD, William Wilson, 216 pp., $3.75, Philosophical Library, New York, New York, 1954.

This book deals with the very small things in the physical world. The greatest part of it is devoted to present day knowledge about atoms and molecules, their structure and behavior. The book is addressed to the intelligent layman and is not burdened with mathematics.

TABOO, Franz Steiner, 154 pp., $4.75, Philosophical Library, New York, New York, 1956.

Scholars have been trying to explain taboo customs ever since Captain Cook discovered them at first hand in Polynesia nearly 200 years ago. But none of the theories so far advanced has more than a limited validity, as is made clear by Dr. Steiner's searching scrutiny, so numerous are the taboos recorded and so diverse the societies in which they occur.

THE BIOLOGY OF SPIDERS, Theodore H. Savory, 376 pp., $4.00, Sidgwick & Jackson, Ltd., London, England.

The book, after describing the spider's structure, deals with its methods of self-production, feeding and reproduction, as illustrating the behavior of a creature of the small-brained instinctive type. The spider's relation to its environment is discussed in detail. Finally, the evolution of the families of spiders is considered, and it is shown how the spider can contribute to our understanding of organic evolution.

ATOMS AND ENERGY, Professor H. S. W. Massey, 174 pp., $4.75, Philosophical Library, Inc., New York, New York, 1956.

This book gives a non-technical account of the developments in atomic physics which led up to the large scale release of atomic energy. The similarities and differences between the atomic processes which occur in ordinary combustion and in nuclear fission are explained in some detail in order to realize the immensity of the new power available. The consequences of this for war and peace are discussed—the nature and possibilities of the hydrogen bomb are fully considered.